



**University of  
Zurich**<sup>UZH</sup>

**Zurich Open Repository and  
Archive**

University of Zurich  
University Library  
Strickhofstrasse 39  
CH-8057 Zurich  
[www.zora.uzh.ch](http://www.zora.uzh.ch)

---

Year: 2018

---

## **Single-phase bilateral low dose contrast medium injection for diagnosing occlusions of the thoracic venous system: a case report**

Svensson, Anders ; Brismar, Torkel B ; Morsbach, Fabian

**Abstract:** Occlusion of the thoracic venous system and/or occlusion of central venous catheters (CVC) of unknown cause can, in selected cases, require advanced imaging. Here, we describe a case study of a patient with a failing central dialysis catheter (CDC) which was diagnosed by computed tomography (CT) in connection with a single-phase bilateral low-dose contrast medium (CM) injection using only 3.6 g of iodine. By injecting a low CM dose, the risk of streak artifacts from first-pass of high intravascular concentrations of CM can be avoided. Therefore, the technique described here should be beneficial also to patients with normal renal function.

DOI: <https://doi.org/10.1177/2058460118778060>

Posted at the Zurich Open Repository and Archive, University of Zurich

ZORA URL: <https://doi.org/10.5167/uzh-159297>

Journal Article

Published Version



The following work is licensed under a Creative Commons: Attribution-NonCommercial 4.0 International (CC BY-NC 4.0) License.

Originally published at:

Svensson, Anders; Brismar, Torkel B; Morsbach, Fabian (2018). Single-phase bilateral low dose contrast medium injection for diagnosing occlusions of the thoracic venous system: a case report. *Acta Radiologica Open*, 7(6):2058460118778060.

DOI: <https://doi.org/10.1177/2058460118778060>

# Single-phase bilateral low dose contrast medium injection for diagnosing occlusions of the thoracic venous system: a case report

Anders Svensson<sup>1,2</sup> , Torkel B Brismar<sup>1,2</sup> and Fabian Morsbach<sup>1,2</sup>

Acta Radiologica Open  
7(6) 1–4  
© The Foundation Acta Radiologica  
2018  
Reprints and permissions:  
sagepub.co.uk/journalsPermissions.nav  
DOI: 10.1177/2058460118778060  
journals.sagepub.com/home/arr

## Abstract

Occlusion of the thoracic venous system and/or occlusion of central venous catheters (CVC) of unknown cause can, in selected cases, require advanced imaging. Here, we describe a case study of a patient with a failing central dialysis catheter (CDC) which was diagnosed by computed tomography (CT) in connection with a single-phase bilateral low-dose contrast medium (CM) injection using only 3.6 g of iodine. By injecting a low CM dose, the risk of streak artifacts from first-pass of high intravascular concentrations of CM can be avoided. Therefore, the technique described here should be beneficial also to patients with normal renal function.

## Keywords

CT, contrast agents – intravenous, thorax, vena cava

Date received: 15 December 2017; accepted: 30 April 2018

## Introduction

Obstruction of the thoracic venous system can be due to numerous reasons, for example thoracic malignancies, especially lung cancer (1,2). Expansive tumor growth leads to a narrowing and eventually total occlusion of the superior vena cava (SVC). Failure of a central line may also occur or exacerbate due to thrombus formation in patients in patients with central venous catheters (CVC) (3,4). Hence, an occlusion of a central dialysis catheter (CDC) constitutes a potential medical emergency. Diagnostic imaging for occlusions in the thoracic venous system SVC syndrome include contrast-enhanced computed tomography (CT), ultrasound/echo-cardiography, magnetic resonance imaging (MRI), or conventional venograms (4).

However, imaging in some patient groups, e.g. in the intensive care unit, may prove challenging. MRI may be inaccessible and ultrasound inconclusive. Furthermore, reduced kidney functions may be of concern in case of CT, as those may need relatively high iodine contrast media application for a complete chest CT (4).

We present an imaging option for a CT venogram with bilateral injection of low dose, diluted contrast medium in a patient with unclear occlusion of a CDC and failure to advance a new central catheter.

## Case report

A 77-year-old male patient with biological aortic valve and pronounced cardiovascular disease (atrial fibrillation, pulmonary hypertension, dilated atriums, and

<sup>1</sup>Department of Clinical Science, Intervention and Technology at Karolinska Institutet, Division of Medical Imaging and Technology, Stockholm, Sweden

<sup>2</sup>Department of Radiology, Karolinska University Hospital in Huddinge, Stockholm, Sweden

### Corresponding author:

Anders Svensson, Department of Clinical Science, Intervention and Technology at Karolinska Institutet, Division of Medical Imaging and Technology, Stockholm, Sweden and Department of Radiology, Karolinska University Hospital in Huddinge, 14186 Stockholm, Sweden.  
Email: anders.svensson@ki.se



mitral and tricuspid valve insufficiency) was referred to the radiology department after inconclusive ultrasonographic (US) Doppler of the thoracic venous system after the patient's current CDC had failed and a new CDC was considered. Due to complete kidney failure without any expected rest function, a protocol with heavily reduced iodine content was developed. Here, we present our thoracic CT venography protocol with diluted contrast medium and bilateral intravenous injection.

The CT scan was performed using a dual source multidetector (MDCT) Somatom Definition Flash® (Siemens Healthcare, Forchheim, Germany). Scan parameters included helical scanning using  $128 \times 0.6$  mm detector collimation at a pitch of 0.9, 100 kVp, and automatic tube current modulation. A simultaneous intravenous bolus injection consisting of sodium chloride (NaCl) and contrast media (CM) solution (Iomeprol 400 mg iodine per mL, Bracco Imaging, Milan, Italy) was performed using a dual head auto injector (Medrad Stellant®, Bayer, PA, USA). To obtain an attenuation of 400 Hounsfield units (HU) in the central veins, it was assumed that the given CM would be further diluted from blood at a ratio of 1:2 after the injection. The injected CM should therefore have an attenuation of approximately  $3 \times 400 = 1200$  HU. After analyzing the attenuation of a set of CM dilutions in vitro (ranging from 200 mg/mL to 20 mg/mL, data not shown), it was concluded that a concentration of 40 mg/mL results in roughly 1200 HU and should be optimal. Thus, each syringe was filled with a solution consisting of 90 mL NaCl and 10 mL CM, resulting in the desired concentration of 40 mg/mL. Of that solution, 45 mL was injected from each syringe through an 18-gauge percutaneous venous catheter (PVC) applied in both left and right medial cubital vein giving a total dosage of 3.6 g iodine. Scan delay was set to 12 s.

Images were reconstructed with 0.75-mm slice thickness and 0.7-mm reconstruction increment. All reconstructed images series were sent to a dedicated workstation (Advantage Work Station® 4.6, GE Healthcare, Milwaukee, WI, USA) for 3D volume rendering (VR) post-processing.

The CT scan showed occlusion of the right subclavian vein along with collateral vessels ending in the SVC. On the left side, there was an elongated stenosis of the brachiocephalic vein along with abundant collateral vessels (Fig. 1–5).

## Discussion

To visualize the central veins, we used 3.6 g iodine, which is approximately a 90% reduction from the



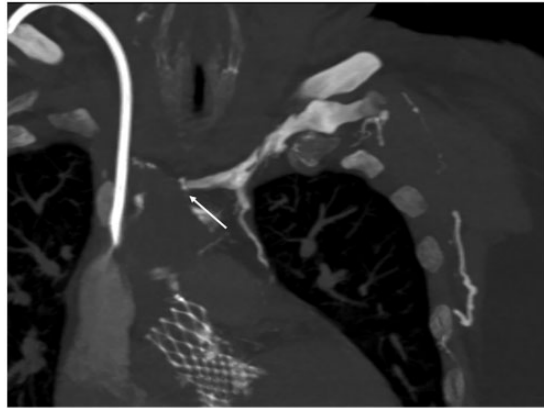
**Fig. 1.** Sagittal-oblique reconstruction with visualization of the hypodense thrombus (arrow A) associated with the catheter's tip (arrow B).



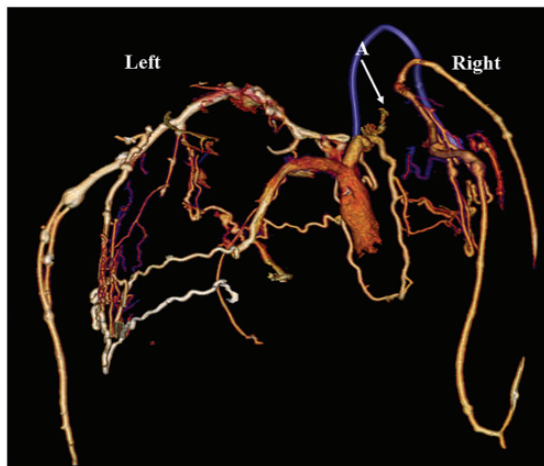
**Fig. 2.** Coronal MIP of the right subclavian vein with thrombus material (arrow A) and total occlusion of the subclavian vein proximally (arrow B).

clinical CM individualized standard CT protocol (up to 500 mg iodine per kg body weight) (6).

Contrast-induced acute kidney injury (CI-AKI) is considered a complication to the use of CM. The widely used definition of CI-AKI is an increase in serum creatinine of 25%, or  $44 \mu\text{mol/L}$ , from baseline within 72 h after the administration of intravascular CM. The complication predominantly affects patients with reduced renal function. In clinical practice, it is considered that the risk of kidney damage increases with the dose of injected CM (7). Therefore, in dialysis patients with residual renal function, it is important to

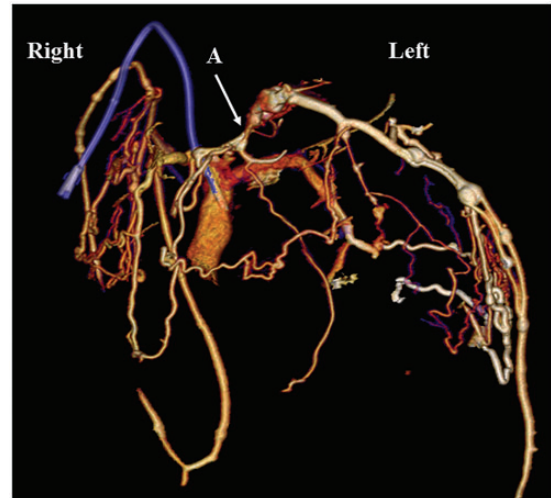


**Fig. 3.** Coronal MIP of the left brachiocephalic vein with proximal occlusion (arrow).



**Fig. 4.** Volume-rendered (VR) 3D image demonstrating complete occlusion of the right subclavian vein (arrow A).

minimize the use of CM to preserve kidney residual function. Although we injected a 10% CM solution, which in total contained only 3.6 g iodine, the dilution effect in the vessels was smaller than expected and an attenuation of approximately 900 HU was obtained in the central veins. This indicates that the CM could be further diluted, reducing the total CM dosage even more. In theory, to achieve 400 HU the dose could be halved, but there will be individual variations due to regional blood flow. Further studies refining the concentration of the injected CM should be performed in those patients where a repeated CM injection would be of less risk of CI-AKI. By injecting a low CM dose, the risk of streak artifacts from first-pass of high intravascular concentrations of CM (8) can be avoided. The technique described in this case report should therefore be beneficial also to patients with normal renal function.



**Fig. 5.** VR 3D image demonstrating proximal subtotal occlusion of the left brachiocephalic vein (arrow A).

There are several non-invasive techniques to evaluate the SVC. The simplest to the patient is US Doppler. However, US Doppler is user-dependent, and the lack of images is easy to interpret as the clinician makes alternative imaging and diagnostic techniques desirable. Magnetic resonance angiography is an appealing alternative, but the risk of necrotizing systemic fibrosis in patients with severe renal failure and scanner availability limits its use (9). Standard CT with intravenous CM is another alternative. However, in patients with renal impairment, this implies an increased risk of CI-AKI.

In cases where patients have limited imaging options or when other imaging options have failed, a CT venogram with a total of >3.6 g iodine, bilaterally injected, might be helpful as an additional way to determine stenosis of the thoracic venous system, especially in cases of suspected SVC syndrome. Furthermore, the anatomical information from CT, including information about collateral vessels, helps making the diagnosis and would be of value to guide interventionalists when planning treatment for the patient (5,10).

#### Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

#### Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

#### ORCID iD

Anders Svensson  <http://orcid.org/0000-0001-5685-7255>

## References

1. Tatu W, Winzelberg G, Boller M, et al. Computed tomographic evaluation of compression of the superior vena cava and its tributaries. *Cardiovasc Intervent Radiol* 1985;8:89–99.
2. Cohen R, Mena D, Carbajal-Mendoza R, et al. Superior vena cava syndrome: A medical emergency? *Int J Angiol* 2008;17:43–46.
3. Quaretti P, Galli F, Moramarco L, et al. Dialysis catheter-related superior vena cava syndrome with patent vena cava: long term efficacy of unilateral Viatorr stent-graft avoiding catheter manipulation. *Korean J Radiol* 2014;15:364–369.
4. Sonavane S, Milner D, Singh S, et al. Comprehensive imaging review of the superior vena cava. *Radiographics* 2015;35:1873–1892.
5. Kim H, Kim H, Chung S. CT diagnosis of superior vena cava syndrome: importance of collateral vessels. *Am J Roentgenol* 1993;161:539–542.
6. Bae K. Intravenous contrast medium administration and scan timing at CT: considerations and approaches. *Radiology* 2010;256:32–61.
7. Thomsen H. European Society of Urogenital Radiology (ESUR) guidelines on the safe use of iodinated contrast media. *Eur J Radiol* 2006;60:307–313.
8. Barrett JF, Keat N. Artifacts in CT: recognition and avoidance. *Radiographics* 2004;24:1679–1691.
9. Thomsen H, Morcos S, Almen T, et al. Nephrogenic systemic fibrosis and gadolinium-based contrast media: updated ESUR Contrast Medium Safety Committee guidelines. *Eur Radiol* 2013;23:307–318.
10. Rachapalli V, Boucher L. Superior vena cava syndrome: role of the interventionalist. *Can Assoc Radiol J* 2014;65:168–176.